The Industries of the Future strategy embraces the development and deployment of technologies that enhance energy and materials efficiency in a broad cross-section of U.S. industry.

Enabling Technologies

Several key technologies are ubiquitous in U.S. industry. Use of these technologies is so widespread that even a small improvement in their energy efficiency can mean substantial energy and cost savings. OIT is helping to focus public and private research investments on industry's most important needs in these crosscutting areas:

- Combustion
- Sensors and Controls
- Industrial Materials of the Future

The results enable improvements in productivity and energy efficiency throughout U.S. industry.

ENABLING TECHNOLOGIES FACILITATE ENERGY-EFFICIENT PROCESSING IN A BROAD RANGE OF INDUSTRIES

Selected Projects	AGRICULTURE	ALUMINUM	CHEMICALS	FOREST PRODUCTS	GLASS	METAL-CASTING	MINING	PETROLEUM	STEEL
Combustion									
•NOx Emissions Reduction by Oscillating Combustion			■		■	■		■	■
•Forced Internal Recirculation Burner	■		■	■	■			■	■
•Radiation Stabilized Burner	■		■	■	■			■	■
•Dilute Oxygen Combustion		■	■			■			■
Sensors & Controls									
•Wireless Telemetry for Industrial Applications	■	■	■	■	■	■		■	■
•Thermal Imaging Control System		■	■		■	■			■
Advanced Materials									
•Nickel Aluminides	■	■	■	■	■	■	■	■	■
•Oxide Membranes			■					■	
•Metals Processing Laboratory	■	■	■	■	■	■		■	■

Combustion

(www.oit.doe.gov/combustion)

Combustion processes provide more than 85% of the energy used by U.S. industry. Industry uses combustion systems to meet process steam and heat requirements as well as to change the mechanical or chemical properties of materials and feedstocks. These functions are vital to the production of basic manufactured goods used in all segments of the U.S. economy.

To address increased competition and regulation, industry needs combustion equipment that offers better performance, lower environmental impact, and greater flexibility—all at a reasonable cost. With support from OIT's Combustion Program, users and manufacturers of industrial combustion equipment have joined forces to guide public and private R&D efforts in meeting the evolving needs of energy-intensive industry.

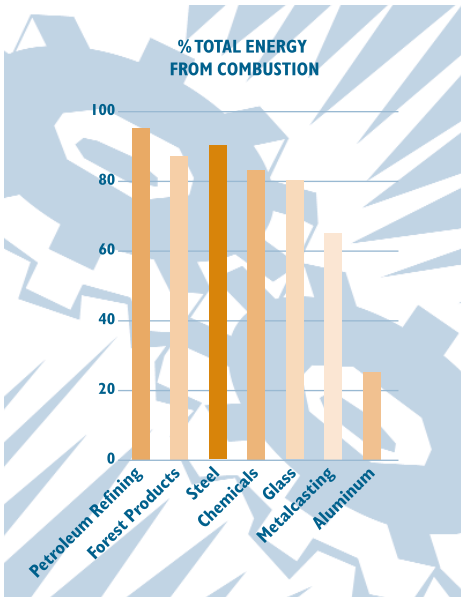
ACTIVITIES

The extended combustion community developed the *Industrial Combustion Vision* in 1998, generating widespread interest in combustion research. The vision described the challenges and set strategic performance targets for advanced combustion technology over the next 20 years.

Equipment users, manufacturers, government, academia, and other research organizations collaborated on the development of the *Industrial Combustion Technology Roadmap* (April 1999), which established a long-term research agenda for achieving the vision. The roadmap priorities include pre-competitive research, burner development, and efficiency improvements in industrial boilers and process heating systems. Industry-defined performance targets include energy-efficient, low-emission boilers that are fuel-flexible, cost-effective, reliable, and safe.

One of the industry's long-term goals is to significantly reduce emissions of NOx and other criteria pollutants from industrial burners. Additional targets call for furnaces and process heaters that produce uniform, high-quality end products at high production rates with low specific fuel consumption and minimal environmental impacts. These combustion systems will be capable of using a variety of different fuels, including some derived from industrial by-products.

OIT's Combustion Program annually solicits proposals for collaborative R&D projects that address the combustion community's priority needs as identified in the technology roadmap.



Sensors and Controls

(www.oit.doe.gov/sens_cont)

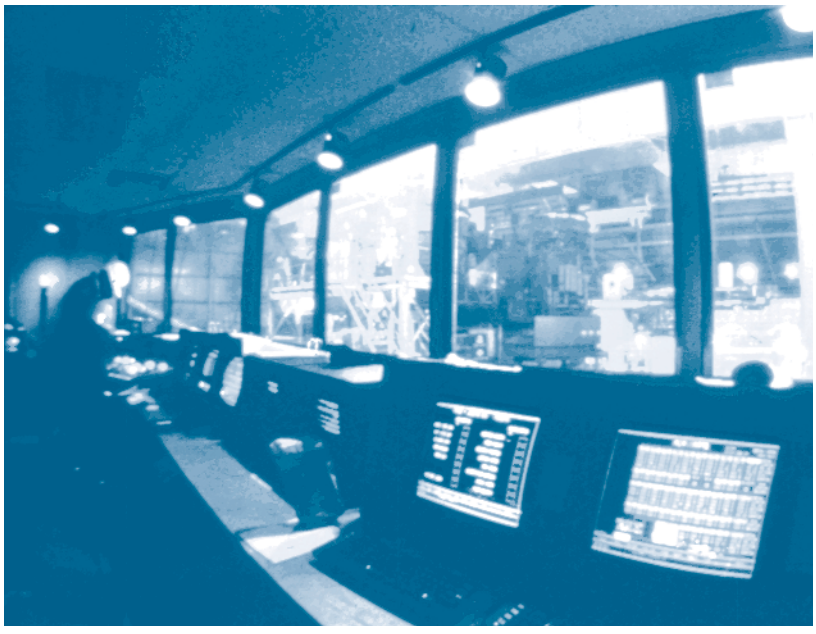
U.S. manufacturers need more accurate and intelligent sensor and control systems to improve energy efficiency, reduce waste and emissions, and boost productivity. The improved process control afforded by these systems can also enhance product quality.

The heat-intensive nature of many primary-processing industries poses special challenges for measurement devices. Sensors and controls have been identified as key technology needs in a variety of industry roadmaps. In particular, R&D is needed to develop sensors that can withstand extremely high temperatures and harsh environments. Advanced materials are opening the door to new possibilities in terms of sensor placement and accuracy, allowing greater proximity to (or immersion in) the materials to be measured. Advances are also needed in technologies for reliably integrating and processing input from different types of sensing devices in order to detect and make corrections to various processing parameters.

ACTIVITIES

OIT's Sensors & Controls (S&C) Program fosters the development and deployment of integrated measurement systems for operator-independent control of manufacturing processes. The S&C Program seeks to advance the key areas of science and technology that underpin the intelligent systems control industry: advanced sensor technology, information processing, and open-architecture systems. Major benefits of this program will include rapid adaptation of technology from one process application to another and avoidance of duplicate technology development efforts. The current goal is to develop a next-generation, intelligent control system capable of operating in harsh environments by 2004.

An S&C Steering Committee has been established to guide the selection of topic areas for upcoming S&C solicitations on the basis of the high-priority R&D needs identified in the technology roadmaps. The committee consists of subject-area experts and members representing six IOF teams, two National Science Foundation Centers, the National Institute of Standards and Technology's Process Measurements Division, and the DOE Laboratory Coordinating Council.



SENSORS & CONTROLS R&D NEEDS

Functions
- On-line, real-time, high-speed measurement
- Materials sorting and inspection
- Emissions and effluents
- Microstructure and inclusion
- Diagnostics and maintenance
- Physical property measurement and analysis

Characteristics
- Miniature sensors or micro-electromechanic systems
- Built-in failure sensing/ self-calibration

Application Environments
- Harsh
- High temperature

Emplacement
- Embedded sensors
- Non-contact measurement

Improved Information Processing
- Advanced signal processing
- Imaging and data
- Modeling and simulation

Open-Architecture, Intelligent Control Systems
- Sensor fusion
- Automation
- Control and optimization

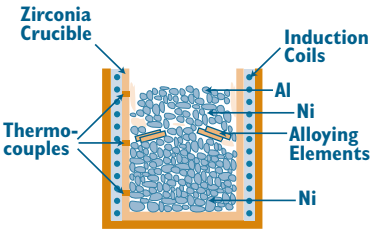
Industrial Materials of the Future

(www.oit.doe.gov/materials)

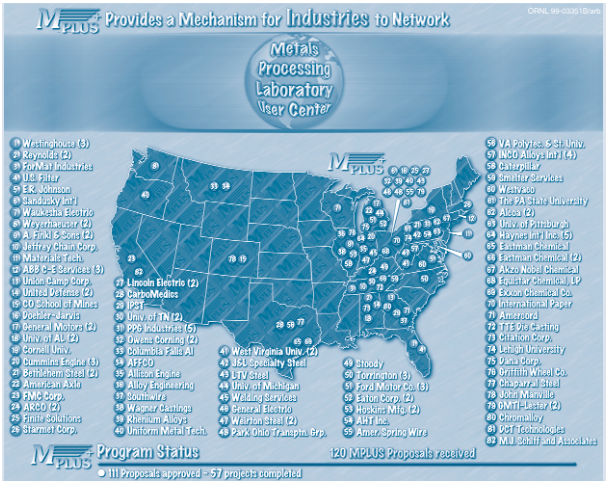
Improved materials are a crosscutting need of many industries and one of the keys to cleaner and more energy-efficient and productive manufacturing. OIT's Industrial Materials of the Future (IMF) program leads a national effort to research, design, develop, engineer, and test new and improved materials and to explore more profitable applications of existing materials. The IMF program conducts a mix of industry-specific and crosscutting R&D, core research, and other directed activities in coordination with the other OIT teams.

Roadmaps developed by several Industries of the Future specifically identify the need for industrial materials that are resistant to corrosion, tolerant of high-temperature and high-pressure environments, and capable of precision operations. Such materials will enable use of higher operating temperatures in processing, thereby increasing energy efficiency and reducing emissions. Stronger, more durable materials for manufacturing processes and equipment can also extend service life, reduce maintenance, increase productivity, and provide other benefits. Several of the crosscutting technology roadmaps (e.g., combustion, sensors and controls) also identify materials as a priority need in developing cleaner and more efficient systems. The IMF program sponsors materials-related R&D to address these **industry-specific and crosscutting R&D** needs, with emphasis given to high-priority needs shared by two or more industries.

The program supports industry-specific R&D projects for one to three years until the technologies are sufficiently mature to compete for IOF team funding. Projects that address crosscutting research needs may be supported for one to five years, as necessary. For both types of projects, OIT's industrial partners contribute at least 50% of costs (averaged over the duration of each project). IMF-sponsored R&D projects do not include technology demonstration or field testing. At that stage of development, promising materials for industrial components, subsystems, and integrated systems are turned over to the appropriate industry-specific or crosscutting team in OIT.



The Exo-Melt Process developed with OIT support applies the energy released during initial exothermic reactions to the remaining melting process. The technology saves 50% of the energy formerly used in making nickel aluminide and was selected to receive an R&D 100 Award.



MPLUS

The Metals-Processing Laboratory Users (MPLUS) Facility assists U.S. industry and university researchers in solving metals-based issues that affect energy efficiency, environmental performance, and U.S. competitiveness. Based at the Oak Ridge National Laboratory, MPLUS features four specialized centers:

- **Metals processing**
- **Characterization and properties**
- **Joining**
- **Process modeling**

In the last two years, MPLUS has received more than 85 proposals for joint projects by 65 companies in 25 states.

NICKEL ALUMINIDE STEEL ROLLS

Applications

- **Transfer rolls in steel reheat furnaces (photo)**
- **Paper drying rolls**
- **Trays for carburizing steel automotive parts**
- **Forging dies for near net shape casting**

Industry-specific and crosscutting R&D activities include projects to

- Develop functional and protective materials for sensors, actuators, and other devices subject to harsh environments
- Improve materials for refractories and other components of industrial furnaces, boilers, and gasifiers
- Develop materials that resist fatigue, corrosion, and wear in caustic, high-temperature environments
- Develop membranes and other materials for cost-effective separations
- Develop economically viable processing methods
- Analyze factors affecting emissions
- Develop comprehensive property databases for industrial materials
- Characterize microstructures and thermophysical properties
- Analyze life cycle costs and benefits

Industrial efficiency may also benefit from advances in the basic sciences that are enabling the development of cost-efficient "smart" materials such as electrochromics, controlled-release devices, and shape-memory alloys. These developments are opening a new world of possibilities—materials that can self-repair, actuate, and transduce. New coatings, films, and microstructures are also making it possible to create materials with a variety of unique and tailored properties.

To take advantage of developments in the basic sciences that may benefit the Industries of the Future, the IMF program devotes a portion of its budget to **core research** activities. Core activities include support for projects that strengthen fundamental understanding of the physical and chemical properties of materials as well as processing methods for materials of interest to the IOFs. These activities bridge the gap between the basic science research conducted by the DOE Office of Science and the advanced materials R&D projects sponsored by OIT. Core activity research projects may receive support from three to seven years.

Finally, the program supports a variety of **directed activities** that provide analysis, guide program development, and otherwise support program objectives. For example, the program will shortly undertake a comprehensive evaluation of the benefits of advanced industrial materials to help clarify the program focus. In particular, this evaluation will assess processing methods and potential for commercialization, determine priorities for the development of fundamental knowledge, and define the decision-making process for continuation or termination of project funding. Other directed activities include support of the Materials Processing User Center (MPlus) and other facilities as necessary to assist the IOFs in addressing short-term materials needs.

The Industrial Materials of the Future program represents a consolidation of OIT's former Advanced Industrial Materials and Continuous Fiber Ceramic Composites Programs. There will be a transition period during which earlier projects will be completed and the new program activities gain momentum.